

A TAXONOMIC REEVALUATION OF *OVATUS MENTHARIUS*
(VAN DER GOOT) (HEMIPTERA: APHIDIDAE)

GARY L. MILLER, SUSAN E. HALBERT, AND ROBERT G. FOOTTIT

(GLM) Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, Bldg. 005, BARC-West, Beltsville, MD 20705, U.S.A. (e-mail: gary.miller@ars.usda.gov); (SEH) Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, FL 32614, U.S.A. (e-mail: halbers@doacs.state.fl.us); (FGF) Agriculture and Agri-Food Canada, Canadian National Collection of Insects, Ottawa, ON K1A 0C6, Canada (e-mail: foottitrg@agr.gc.ca)

Abstract.—We reevaluate the status of *Ovatus mentharius* (van der Goot) in North America which was previously misidentified as *Ovatus crataegarius* (Walker). Detailed keys for separating *O. crataegarius* and *O. mentharius* on Labiatae, descriptions of apterous viviparae and the alatae of *O. mentharius*, morphometric analysis, distribution records, and illustrations of *O. mentharius* are presented.

Key Words: aphid, mint, adventive species

The genus *Ovatus* was proposed by van der Goot in 1913. Some species of this genus host alternate between *Craetaegus* or other woody Pomaceae and Labiatae while other species are monoecious, associated with Labiatae or other herb families (Heie 1994). A systematic evaluation of *Ovatus* (sensu Remaudière and Remaudière 1997) in North America by Jensen and Stoetzel (1999) resulted in its revision and subsequent placement of four endemic North American species into the genus *Abstrusomyzus* Jensen and Stoetzel. Their revision left a single species of *Ovatus* in North America, *Ovatus crataegarius* (Walker), which is considered Palearctic in origin but has a worldwide distribution (Jensen and Stoetzel 1999).

Adventive aphid species represent approximately 18% of the North American aphid fauna (Foottit et al. 2006). Recent interceptions of *Ovatus mentharius* (van

der Goot) identified by us (GLM and SEH) and others (e.g., Floren 2004) at various ports-of-entry and greenhouse facilities within the United States have brought our attention to this Palearctic species. It also raised concerns that yet another adventive aphid species may represent an ecological threat. All holdings of *O. mentharius* within the National Museum of Natural History Aphidoidea Collection (USNM), Beltsville, MD, were from port interceptions originating from Europe. Further examination of holdings of *O. crataegarius* revealed intermittent collections of *O. mentharius* that had been previously misidentified as *O. crataegarius* from as far back as 1935. Some of these collections represented border interceptions, but the earliest record of this species (California in 1935) was possibly not an interception. In addition to the recent port interceptions, discovery (and subsequent eradi-

cation) of *O. mentharius* within experimental plots containing mint (*Mentha spicata* L., *M. suaveolens* Ehrh., and *Mentha* sp.) and basil (*Ocimum basilicum* L.) and on *Mentha* spp. at an organic greenhouse operation in Florida raised our concern that this species could be pestiferous. *Ovatus mentharius* in Florida represents the easternmost distribution of the species in the U.S.A.

Ovatus mentharius is holocyclic and monoecious on *Mentha* spp. while *O. crataegarius* is holocyclic and heteroecious with *Mentha* spp. serving as secondary hosts (Heie 1994). Mixed infestations of the two species and morphological similarities sometimes make identification difficult. The current study was undertaken to reevaluate the status of *O. mentharius* in America North of Mexico by providing descriptions, illustrations, keys for separating *O. crataegarius* and *O. mentharius*, distribution records of *O. mentharius*, and morphometric analysis of *O. crataegarius* and *O. mentharius* for additional species clarification.

MATERIALS AND METHODS

Synoptic descriptions are taken from original descriptions and specimens from The Florida State Collection of Arthropods (FSCA), Gainesville, FL, U.S.A. and the National Museum of Natural History Aphidoidea Collection (USNM), Beltsville, MD, U.S.A. Measurements are in micrometers (μm) as minimum and maximum ranges of representative specimens. Table 1 also includes summary statistics (range, mean, and standard deviation) for *O. crataegarius* and *O. mentharius*. Drawings were begun using a camera lucida and completed either by hand or by computer-aided illustration programs (Adobe Photoshop®). Most specimens had been cleared and mounted or remounted in Canada balsam.

Morphological terms and structures adapted from Foottit and Richards (1993)

are used in this work. Abbreviations herein for body length, antennal segment(s), aptera/apterae (=wingless viviparous female(s)), alata/alatae (=winged viviparous female(s)), and immature(s) are listed as: b.l., a.s., ap., al., and imm., respectively. If a collection was made at the same locality, but on a different date as a previously listed collection, duplicated information is not repeated. Months are designated as roman numerals. For example, the documentation provided for a particular locality may be recorded as: FLORIDA: Tallahassee, VI-6-1989, on *Ocimum basilicum*, D. C. Beard coll., (2 ap.) USNM; V-10-1990, VI-29-1991, I-21-1992, on mint [*Mentha* sp.], (5 ap. on 5 sl.) USNM. In this hypothetical example, the second collection was also found at Tallahassee, even though "Tallahassee" was not repeated. Collection data that are the same except for collection date are simply listed sequentially. In examples where microscope slides record a county, they are listed first within each state then chronologically. Other collection localities are listed chronologically. When specimens are mounted on a single slide (sl.), it is not written as such but is assumed. Bracketed ([]) text represents supplemental information by the current authors for clarification purposes.

Specimens of the adult apterous viviparous morph were used for morphometric analysis. Bracketed letters (e.g., {A}) in the "Specimens examined" section for *O. mentharius* indicate those specimens that were used in the analysis. Seventy-three slides of *O. crataegarius* were examined from the USNM. Single representative specimens of *O. crataegarius* that were measured and used in the analysis are as follows. MEXICO: [intercepted at San Ysidro, CA [?] interception # 2536], II-27-1961, on *Mentha* sp., J. Spear coll., USNM; [intercepted at Chicago, IL, interception # 4785], III-28-1963, on *Mentha* sp., Rood coll., USNM;

Table 1. Summary statistics (range, mean and standard deviation) for measurements of *Ovatus crataegarius* and *Ovatus mentharius* in μm , and standardized total sample coefficient (loadings) for variables used in canonical discriminant analysis.

Variable	<i>O. crataegarius</i> n=10			<i>O. mentharius</i> n=11			Standardized CVA Coefficient
	Range	Mean	Std Dev	Range	Mean	Std Dev	
body length	1235-1910	1528.5	218.44	1060-1790	1390.5	270.61	-0.12
head width	325-475	386.5	49.44	300-400	345.9	36.93	-3.40
a.s. III length	315-490	424.0	58.16	300-490	375.9	60.78	-9.66
a.s. IV length	235-355	297.5	41.98	210-390	290.5	62.51	
a.s. V length	225-315	275.0	31.45	180-350	265.0	56.26	3.25
a.s. VI base length	95-135	107.0	12.95	85-115	99.1	11.14	-3.98
a.s. VI terminal process	405-590	492.0	49.51	425-590	495.5	50.67	-2.10
ultimate rostral segment length	110-140	120.0	10.80	100-135	116.8	10.79	-3.15
ultimate rostral segment width	35-70	46.0	10.22	35-50	41.4	5.95	3.42
fore femur length	265-475	351.0	69.63	235-375	315.0	53.95	
fore tibia length	460-825	627.0	122.07	450-715	570.5	92.15	
fore tarsus segment II length	60-100	74.5	12.12	60-80	70.5	7.23	-2.07
mid femur length	275-470	362.5	66.89	240-400	323.2	59.84	
mid tibia length	495-855	641.5	114.02	450-765	590.9	107.35	0.54
mid tarsus segment II length	65-100	76.0	11.01	65-80	72.3	6.47	-5.06
hind femur length	350-610	458.5	86.89	300-515	390.5	72.27	
hind tibia length	650-1175	860.0	167.88	590-935	768.2	111.63	15.28
hind tarsus segment II length	60-100	77.5	11.61	60-95	74.5	10.36	1.07
siphunculus length	260-460	334.0	58.96	265-455	345.5	63.58	10.27
intersiphuncular distance	240-475	340.5	71.16	215-385	286.4	56.04	-2.13
cauda length	125-210	160.0	23.09	125-190	148.6	22.92	-6.01

[intercepted at Hidalgo, TX, interception # 6845], VIII-4-1986, on *Mentha* sp., A. Munoz coll., USNM. UNITED STATES: IDAHO, New Plymouth, III-22-1973, on mint, A. M. Finley coll., USNM. INDIANA, Warsaw, VIII-8-1933, on peppermint, G. E. Gould coll., USNM. MARYLAND, Beltsville, X-6-1975, on [?], S. W. T. Batra coll.; X-7-1997, on *Mentha* sp., A. Jensen coll., USNM. NEW YORK, Ludlowville, VIII-22-1974, on *Mentha spicata*, L. L. Pechuman coll., USNM. UTAH, Brigham, VIII-18-1973, on *Mentha spicata*, G. F. Knowlton coll., USNM. WASHINGTON, Prosser, VII-30-1956, on peppermint, K. E. Frick coll., USNM.

Each specimen was measured for the following 21 variables (Table 1) (operational dimensions for most variables are as indicated in Footitt and Mackauer, 1990): b.l., head-width (through eyes), a.s. III-length, a.s. IV-length, a.s. V-length, a.s. VI base-length, a.s. VI processus terminalis-length, ultimate rostral segment-length, ultimate rostral segment-width, fore femur-length, fore tibia-length, fore tarsus segment II-length, mid femur-length, mid tibia-length, mid tarsus segment II-length, hind femur-length, hind tibia-length, hind tarsus segment II-length, siphunculus-length, intersiphuncular distance, cauda-length.

We used principal component analysis to investigate relationships among specimens and variables and we used canonical variates analysis to determine those variables which best separated groups of specimens (Footitt and Mackauer 1990). All statistical analyses were carried out using SAS version 9.1 for Windows® (SAS Institute Inc., Cary, North Carolina).

RESULTS

Ovatus van der Goot 1913

Ovatus van der Goot 1913:84. Type species: *Myzus mespili* van der Goot, 1912: 64; (= *Aphis insitus* Walker, 1849: xxxix). By original designation.

North American diagnosis.—Small to medium aphids (b.l. 1,000–2,500). Antennae 6-segmented, longer than body in apterae and alatae; apterae without secondary sensoria, alatae with numerous secondary sensoria on a.s. III, fewer on a.s. IV, and frequently on a.s. V. Head spiculated, lateral frontal tubercles well developed with prominent convergent rounded processes on the inner sides. Apical rostral segments longer than hind tarsus II. Forewing length of alatae ca. 1.5 times body length. First tarsal segment with 3-3-3 hairs. Dorsal body setae shorter than those on venter; abdomen with irregularly-shaped sculpturing separated by smooth space, without large dorsal patch although smaller faint sclerites present. Siphunculi longer than cauda, with imbrications and distinct flange. Cauda elongate, spiculated with 5–7 setae.

Notes.—Various authors (e.g., Eastop and Hille Ris Lambers 1976, Remaudière and Remaudière 1997) have erroneously recorded "*Ovatus mespili* van der Goot (1913)" as the original combination of the type species. In fact, *Ovatus* was described by van der Goot (1913) with *Myzus mespili* van der Goot (1912) (= *Ovatus insitus* (Walker)) as the type

species. Jensen and Stoetzel (1999) provided characters for separating *O. crataegarius* in North America from similar taxa in the genera *Abstrusomyzus* Jensen and Stoetzel, *Hyalomyzus* Richards, *Myzus* Passerini, and *Phorodon* Passerini. *Ovatus* species can be either holocyclic and heteroecious or holocyclic and monoecious. For example, *O. crataegarius* has primary hosts *Crataegus* and other Rosaceae and secondary hosts *Mentha* spp., while *O. mentharius* is holocyclic and monoecious on *Mentha* spp. (Heie 1994).

Ovatus mentharius (van der Goot 1913)
(Figs. 1–9)

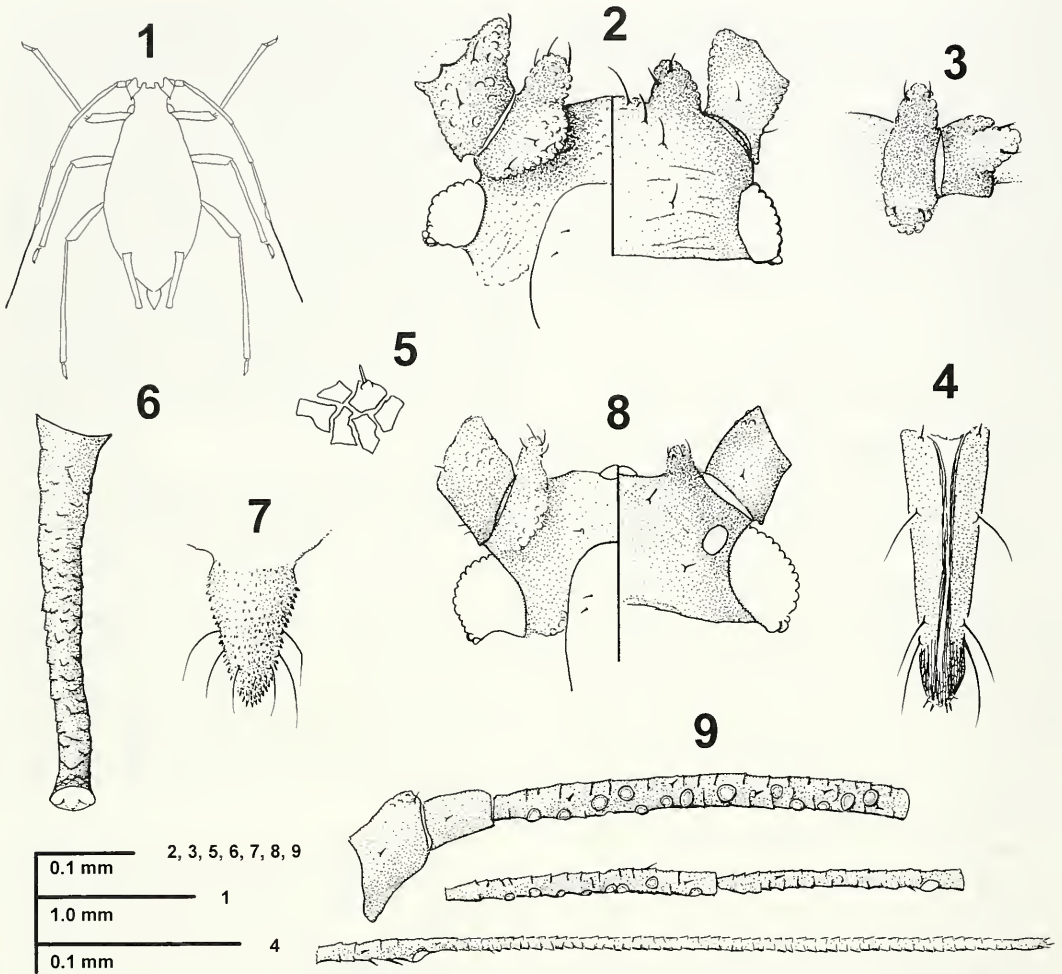
Phorodon mentharius van der Goot 1913: 82.

Ovatus menthastri Hille Ris Lambers 1947: 303.

Ovatus mentharius (van der Goot): Eastop and Hille Ris Lambers 1976: 329; Remaudière and Remaudière 1997: 135.

Field features.—Fundatrices and apterae "pale whitish green" (Hille Ris Lambers 1947). Alatae "green" (Hille Ris Lambers 1947) or more specifically, head and thorax brownish green, abdomen green, antenna black, siphunculus brownish with paler bases, wings with brown-bordered veins (Heie 1994); oviparae "pale greenish yellow" (Hille Ris Lambers 1947).

Recognition characters.—*Apterous vivipara* (Fig. 1): b.l. 1,060–1,790; width through eyes, 300–400 Head (Fig. 2) sclerotized and scabrous; antennal tubercles well developed, converging and bearing setae (Figs. 2, 3); tips of dorsal head setae blunt. Antenna (Fig. 1) longer than body, a.s. I (Figs. 2, 3) with anterior projection, occasionally obscured on some specimens due to orientation in mounting medium, a.s. VI and tip of V darker than other segments on mature specimens, setae less than half width of



Figs. 1-9. *Ovatius mentharius*. 1, Apterous vivipara dorsal habitus. 2, Right side, apterous vivipara dorsum of head and a.s. I; left side, apterous vivipara venter of head and a.s. I. 3, Lateral view of head and a.s. I of apterous vivipara. 4, Ultimate rostral segment. 5, Dorsal abdominal reticulation. 6, Siphunculus of apterous vivipara. 7, Cauda of apterous vivipara. 8, Right side, alata dorsum of head and a.s. I; left side, alata venter of head and a.s. I. 9, Alata a.s. I-VI.

segment; a.s. III 300-490 long without secondary sensoria; a.s. IV 210-390 long without sensoria; a.s. V 180-350 without secondary sensoria; base of a.s. VI 85-115 long; terminal process, 425-590 long. Rostrum extending past metacoxae; ultimate segment (Fig. 4) 100-135 long, approximately 3 times as long as wide at base, with 2 accessory setae. Fore femur 235-375, fore tibia 450-715 long, fore tarsus II 60-80 long; mid femur 240-

400, mid tibia 450-765, mid tarsus II 65-80 long; hind femur 300-515, hind tibia 590-935, hind tarsus II 60-95 long. Abdomen dorsally with distinct irregular reticulations separated by smooth areas (Fig. 5), occasionally with small faint lateral sclerites, dorsal setae stout with blunt tips, ventral setae longer with pointed tip, segment VIII with 4-6 setae; ventrally spiculose; anal plate with 6-8 setae, genital plate with normal configu-

ration of setae. Siphunculus (Fig. 6) 265-455 long, scabrous, tapering slightly and occasionally slightly curved with several rows of hexagonal cells below apical flange. Cauda (Fig. 7) 125-190 long, elongate, tongue-shaped with 2-3 pairs of lateral setae.

Alata (Fig. 8): Similar to apterous female except: b.l. 1,175-1,675; width through eyes 310-375. A.s. I (Fig. 9) protuberance not as pronounced as in apterae, a.s. III 350-425 long, with 19-26 sensoria; a.s. IV 225-390 long, with 4-15 secondary sensoria; a.s. V 205-330 long, with 0-1 secondary sensoria; base of a.s. VI 90-110 long; terminal process 490-600 long. Ultimate rostral segment 115-125 long. Forewing length 1,650-2,500, 550-860 at widest point; hindwing 900-1,475 long, 250-420 at widest point. Fore femur 330-455, fore tibia 650-835 long, fore tarsus II 60-80 long; mid femur 300-400, mid tibia 600-825 mid tarsus II 60-80 long; hind femur 375-535, hind tibia 810-1,100, hind tarsus II 70-90 long. Siphunculus 225-350 long. Cauda 125-140 long.

Morphometric analysis (Table 1).—Initial principal component analysis indicated that a large component (75%) of the morphological variation within the specimens was the result of size-related influences. We reduced the number of variables to 16 from 21 by eliminating a.s. IV—length, fore tibia—length, and the three femur—length measures as these variables were highly correlated (over 95%) with other variables. Two specimens of *O. crataegarius* (Idaho, III-22-1973 and Maryland, X-6-1975) were eliminated from further analysis as they were likely distorted by compression from the slide-mounting process.

Further principal component analysis showed that there was a broad distribution of specimens of both species along a size-related axis which still accounted for approximately 70% of the total variation. This trend indicated that many

of the variables would be sufficiently influenced by size variation as to be ineffective as species-level discriminators. The analysis indicated that among the specimens of *O. mentharius* there is less variation in the a.s. VI, base-length and the ultimate rostral segment—length, than in *O. crataegarius*.

The canonical variates analysis, which incorporates the overall variation among the specimens, completely separated the two sets of species representatives on the basis of significant contributions from a number of variables. *Ovatus crataegarius* is characterized by a longer cauda and a longer antennal segment III compared to those of *O. mentharius*. *Ovatus mentharius* is characterized by longer legs and a longer siphunculus.

Notes.—Identification should consist of a series of specimens when possible. This is especially true when certain characters such as antennal projections can be obscured or altered during the slide-mounting process. In addition, there is variability within such characters as secondary sensoria. For example, one specimen had 21 and 26 secondary sensoria on left and right side a.s.III, respectively. This upper count of secondary sensoria is even higher than the upper range (21) Heie (1994) recorded for *O. mentharius*.

Specimens examined.—MEXICO: Juarez [intercepted at El Paso, TX, interception #'s 66434, 69197, 00865], V-20-1966 {A}, VIII-19-1967 {B}, IX-14-1970, on *Mentha* sp., [various collectors include] D. S. Cambell, J. Kline, C. Oliver colls., (5 ap. on 3 sl.) USNM; Torreon, [intercepted at El Paso, TX, interception # 001508], IX-2-1970 {C}; on *Mentha* sp., D. Mayer coll. (4 ap. and 1 imm.) USNM; [interception at San Ysidro, interception # 2535], II-27-1961 {D}, on *Mentha* sp., J. Spear coll. (3 ap.) USNM; [interception at Chicago, IL, interception # 4540], X-18-1962, on *Mentha* sp., Rood coll. (1 ap.) USNM;

[interceptions at El Paso, TX, interception #'s 61498, 71850, 70484], X-13-1962, III-12-1968, XII-15-1968 {E}, on *Mentha* sp., [and] mint, [and] "misc. mosses" [dubious host association],[various collectors include] G. Dunn, J. W. Green, McClain , C. Oliver colls., (10 ap., 2 al. 1 imm. on 5 sl.) USNM; [interception at Atlanta, GA, interception # 0502015], VI-20-2004 {F}, on *Mentha* sp., P. Haney coll. (3 ap. on 3 sl.) FSCA, USNM; [interception at San Francisco, CA, interception # 0505031], V-30-2005 {G}, on *Mentha* sp., J. Iniguez coll. (3 ap.) USNM. UNITED STATES: CALIFORNIA, Berkeley, III-30-1935 {H}, on *Mentha spicata*, E. O. Essig coll., (7 ap., 4 al., 2 imm. on 8 sl.) USNM. FLORIDA, Orange Co., Apopka, III-1-2006 {I}, on *Mentha* sp., L. Osborne coll., (2 al. on 2 sl.) FSCA, USNM; Suwannee Co., Live Oak, VI-1-2006, on *Mentha* sp., L. L. Davis coll., (2 ap. on 2 sl.) FSCA, USNM. NEW MEXICO, Mesilla Park, IV-25-1956 {J}, on mint, J. J. Durkin coll., (2 ap.) USNM. UNDETERMINED [labeled "Ariz to Juarez to El Paso] V-12-1964 {K}, on *Mentha* sp., Overmiller coll., (1 ap., 1 al., 1 imm.) USNM.

KEY TO NORTH AMERICAN *OVATUS*
VIVIPARAE ON MINTS

1. Antennal segment tip V and VI dark in mature adults; apterous viviparous a.s. I with forward projecting process on inner side (Figs. 2, 3) (on slide-mounted specimens this is sometimes difficult to see); siphunculus often longer than distance between inner bases (Fig. 1); alatae a.s. III with 19-24 secondary sensoria (occasionally more). a.s. IV with 4-13 (occasionally more) secondary sensoria
 *Ovatus mentharius* (van der Goot)
- Antennal segments I-VI predominantly dark in mature adults; apterous viviparous a.s. I without forward projecting process on inner side; siphunculus usually shorter to subequal (occasionally longer) than distance between inner bases; alatae a.s. III with 27-34 secondary sensoria (occasionally less), a.s. IV with 12-17 (occasionally less)

secondary sensoria
 *Ovatus crataegarius* (Walker)

Conclusions

Identification of *O. mentharius* in North America has been problematic due to morphological similarities with *O. crataegarius* and a partial overlap of host plants. However, current morphometric analysis supports the contention that they are indeed separate species. This separation is especially critical not only taxonomically but also from an economic standpoint. The economic importance of the mint hosts (e.g., *Mentha spicata*) could be a major concern in the spearmint growing region of the Pacific Northwest. In addition, our report of basil as a host represents an additional concern for the fresh herb industry. On a positive note, even though *O. mentharius* had been recorded from California as early as 1935, there have been apparently no major populations collected since that time. This also is borne out through the absence of *O. mentharius* in extensive collecting of one of us (SJH) in this region of the continent.

Adventive species of sternorrhynchous Hemiptera in North America have been the subjects of concerted efforts recently (e.g., Miller et al. 2002, Miller and Miller 2003, Miller et al. 2005, Foottit et al. 2006). The numbers and rates of introductions of the Coccoidea and Aphidoidea have nearly mirrored each other for the past two centuries (Miller et al. 2005, Foottit et al. 2006). Foottit et al. (2006) determined that 262 species of aphids should be considered adventive to America North of Mexico. It is possible that *O. mentharius* could represent an addition to this tally. However, with the exception of the recent collection and eradication of *O. mentharius* in Florida, it seems as though establishment is suspect except in a greenhouse situation.

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